

Argonne National Laboratory

**SMEAR STUDY OF D205
(CHEMICAL ENGINEERING BUILDING)**

by

Frank P. Marchetti

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Industrial Hygiene and Safety Division

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ABSTRACT

The smear study shows that at least 80% of the floor-smear surveys which were made in a clear area of the Chemical Engineering Building during the course of this study indicated radioactivity equal to or less than 10 d/m/ft^2 alpha and equal to or less than 200 d/m/ft^2 beta-gamma. The smear survey technique is excellent for use in a high-hazard area, such as a plutonium facility. It is capable of detecting as little as 10 d/m/ft^2 of alpha contamination with a high degree of confidence. The smear survey is also useful in determining if the radioactivity on an item is low enough so that it may be removed from an active area.

INTRODUCTION

A smear study was made to ascertain the amount of removable radioactivity in d/m/ft^2 on the floor in various areas in Building D205 on the site of the Argonne National Laboratory.

The smear survey is defined as the survey or counting of a substance which has been used to wipe a surface. The details of the technique used for this study is presented in a section below.

The study showed that at least 80% of the floor-smear surveys which were made in a clear area indicated radioactivity equal to or less than 10 d/m/ft^2 alpha and equal to or less than 200 d/m/ft^2 beta-gamma. This fact is very useful in the description of a clear area and a clean object, for example, when one must decide if the radioactivity on an item is low enough so that it may be removed from an active area.

The floor-smear data have practical value in the assay of levels of contamination below the sensitivity of portable survey instruments. This is especially true when surveying for contamination by plutonium, which is extremely hazardous. This survey technique is also very useful because of the situation existing in the plutonium-handling facilities. The self-monitors (10-wire gas-flow probe affixed to an AC-operated count rate meter) are able to detect less contamination than most portable survey instruments, or

approximately 300 d/m compared with 500 d/m. It is frustrating when contamination levels within this range are detected with the self-monitors, yet Radiation Safety personnel have difficulty detecting it with portable survey instruments.

In order to improve the statistical confidence in the data, the following steps were taken: (a) the data were collected over a one-year time period (May 1, 1960, to May 1, 1961); (b) the smears were taken at random time intervals - as time permitted; (c) about 5 typical locations within each area were selected; i.e., in front of hood, center of aisle, etc., for the smear survey, and each time an effort was made to choose a different location from the same general area for the smear. This was an effort to avoid any error that might be introduced by the cleaning effect of the previous smear; (d) six (6) different persons performed the surveys.

PROCEDURE

The procedure used in taking a floor smear was as follows:

1. Acetone was sprayed from a wash bottle onto a piece of HV-70 filter paper (approximately 9 in. x $4\frac{1}{8}$ in.).
2. With the flat of the hand over the filter paper, one square foot of floor area was wiped (smeared).
3. The smear was placed between the halves of a paper towel and carried to the counters, where the acetone was allowed to evaporate.
4. The HV-70 paper was counted with routine air-sampling counting equipment - 5 min for alpha and 5 min for beta-gamma.
5. The necessary calculations were performed (subtraction of background and division by the counter yield).
6. The results were recorded on a data sheet.

PRESENTATION OF THE DATA

A summary of the 914 smear surveys is presented in tabular form, according to room locations, in Table I. L-Corridor and offices plus the lunchrooms were considered to be the "clear" area. The number of smears, average smear results, and range per area are listed in Table I according to rooms. The numbers given in the columns marked "At least 80% of the smears less than or equal to" are presented to describe the most usual survey results and to counter the effect on the average of a few high readings.

The data for each area was grouped into frequency tables and histograms (see pages 9 to 23). From these, one can study the distribution of the data. A brief description of the type of work and radioactive material used in each area is given below.

DISCUSSION

The smear survey technique is excellent for use in plutonium-handling facilities because levels of alpha contamination as low as 10 d/m/ft^2 can be detected with reasonable accuracy. A disadvantage is the delay in obtaining results, i.e., the time necessary to collect, dry, count, and calculate. However, this is a small price to pay for the added margin of safety when monitoring areas in which high-hazard materials, such as plutonium, are used. For obvious reasons, it would be impractical to attempt a complete room survey by means of the smear technique. It can be used only as an indication of the loose contamination in the room.

The ability to detect very small quantities of activity by the smear survey is very useful when surveying items that are scheduled to leave "active" areas for a "clear" area. It is sometimes advisable to use a different solvent, such as alcohol, because acetone (the solvent used in this study) may damage the item being surveyed by removing the paint. A highly volatile solvent is preferable to water, because the former will dry quicker and counting can begin sooner. Care must be taken to be sure that the solvent has evaporated completely prior to counting; otherwise, the nylon screen in the alpha probe may be damaged.

The information contained in the histograms is intended as a reference. For example, results of subsequent floor smears can be compared with this information in order to determine if the quantity of contamination in the area is increasing.

As expected, the plutonium-handling facilities, with their self-monitors and specialized handling techniques, had the least contamination.

The size of the grouping used in the histograms was influenced by the yield of the counters. The alpha counter yield is about 20%, making one net count per minute equal to about 5 d/m. The beta-gamma counter yield is about 3%, making one net count per minute equal to about 33 d/m. The groupings were chosen so as to represent about 2 to 3 net counts per minute. Larger groupings were often used for the sake of convenience. Only in one case, that of the clear area, was a smaller grouping used.

Based on the results of this study, any item smear surveyed in D205 (after an instrument survey fails to reveal any contamination) which has

less than 11 d/m/ft² alpha and less than 201 d/m/ft² beta-gamma contamination, will be considered clean by definition, assuming that all possible surfaces of contamination are accessible.

ACKNOWLEDGEMENTS

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Table 1
SUMMARY OF SMEAR STUDY DATA BY ROOMS

D205 Area	Number of Smears	Alpha (d/m/ft ²)				Beta-Gamma (d/m/ft ²)			
		Average	Range		At least 80% of smears less than or equal to	Average	Range		At least 80% of smears less than or equal to
			From	To			From	To	
L-Corridor and Offices	67	5	0	28	10	93	0	780	200
A-133	35	18.4	0	147	30	166	0	870	300
A-141	53	18.1	0	120	30	147.5	0	450	250
B-101	69	60.5	0	273	90	730.8	0	4,900	800
B-133	52	454	6	4,980	800	1,108	0	8,070	1,500
F-111	75	195	20	2,120	250	2,920	129	55,000	3,000
G-101	50	26	6	91	40	2,237	67	9,100	4,000
G-117	59	90.5	20	294	140	509	0	3,500	800
H-102	60	90	15	1,000	90	883	0	25,500	700
H-125	55	47	0	153	100	9,698	120	426,000	1,500
J-102	77	529	57	4,630	900	2,265	292	16,750	3,500
J-118	79	847	58	3,490	1,600	2,853	344	15,700	5,000
J-134	89	1,507	50	13,820	2,500	5,512	200	41,968	8,000
K-104	42	46	4	128	70	2,009	0	29,450	1,200
K-116	52	77	0	584	100	2,645	0	46,300	2,200
D205	914	335	0	13,820	500*	2,395	0	426,000	3,000*

*Active areas only (not including L-Corridor and Offices).

DESCRIPTION OF VARIOUS D205 AREAS

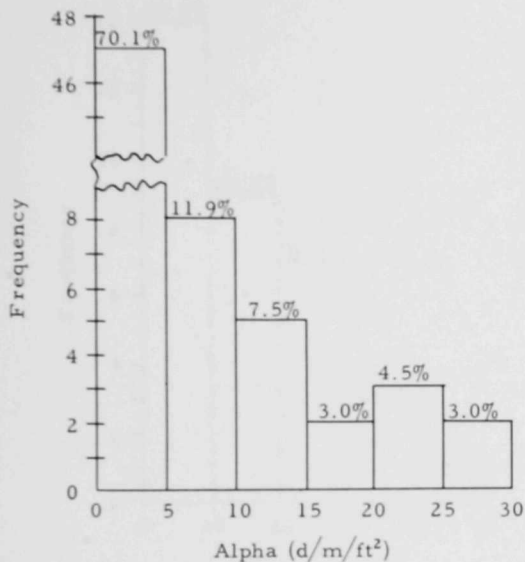
L-Corridor and Offices: This includes the lunchrooms and is outside the "active" area.

A-133: This room contains a plutonium glove box and open hoods. It is used primarily for plutonium analysis. Occasionally, other plutonium-handling operations are performed. Several self-monitors are in service.

- A-141: This area is used primarily for the study of plutonium fluoride chemistry. Blickman hoods that have been converted to glove boxes are used for this work. Several self-monitors are in service.
- B-101: This area contains approximately 18 Blickman hoods. They are used for analytical work and preparation of samples for the counting room. The radioisotopes used are primarily plutonium, uranium, and fission products.
- B-133: Kilogram quantities of thorium "spiked" with enriched uranium were handled in this area during this study. The aim was to produce samples of thoria gel and develop production techniques. This was done in hoods and on bench tops.
- F-111: This is an active storage area. Large quantities of active materials move in and out of this area.
- G-101: This area contains the Junior Cave. "Medium hot" samples are dissolved and aliquots taken in the cave by remote techniques. The aliquots are transferred to B-101, the analytical lab (see above). The Cave is also used to decant and separate samples. The hoods in the room are used for some analytical work.
- G-117: Two large glove boxes, designed for the study of techniques that can be used to separate plutonium from uranium through their fluorides and fluidized beds, are contained in this room. Other normal uranium experiments are also conducted in this room. Self-monitors are in service.
- H-102: There are 4 walk-in type hoods and a plutonium glove box in this room. Experiments involving as much as 100 gm of plutonium in metallic form have been performed. Other experiments, involving kilogram quantities of uranium, are also performed in this area. A self-monitor is in service near the glove box.
- H-125: This room contains 3 cells that are 6 levels high. One of the cells contains a mock-up of the EBWR steam system. Irradiated uranium is introduced into the system to study where contamination would deposit in the event of a fuel rupture. It is also used to study decontamination techniques. Normal uranium is loaded into capsules for irradiation. The irradiated uranium samples are unloaded and examined after irradiation.
- J-102: One corner of this room contains 2 Blickman hoods used in a particle size study. Fluidized beds of uranium are screened and the various sized screened particles are weighed.

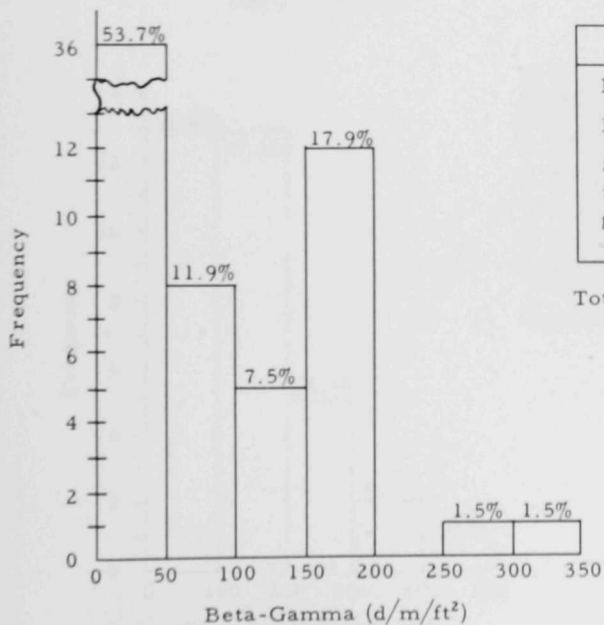
- J-118: The chemistry of uranium under fluidized bed conditions is being studied in vacuum frame-type hoods.
- J-134: This room contained a pie-shaped wedge of the EBR-II fuel-processing facility being built in Idaho. About 100 ingots containing approximately 10 kg each of 50% enriched uranium were prepared in this facility. This is the material used to prepare the first fuel pins for EBR-II. Remote handling techniques were developed.
- K-104: This is the operating area of the Senior Cave. No transfers of radioactive materials are made from this area. It is used for vision and manipulations. Some tools are transferred into the cave from this area.
- K-116: This is the service area of the Senior Cave. All movements of samples and waste, in and out of the Cave, go through this area.

HISTOGRAMS OF SMEAR SURVEYS

L-Corridor and Offices (Clean Area)

Alpha (d/m/ft²)	
Mean	5
Range	0 to 28
Samples not included on graph	None

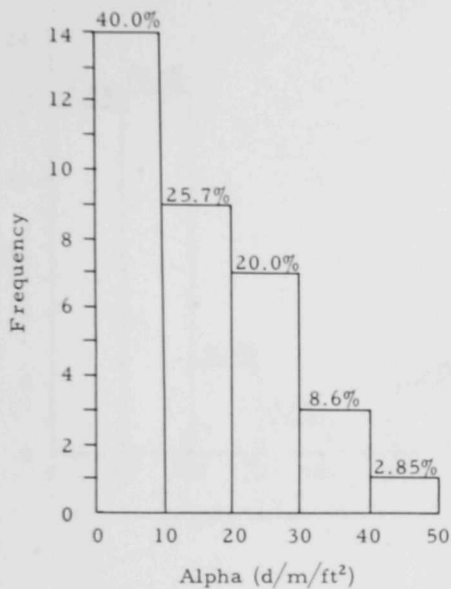
Total number of surveys: 67



Beta-Gamma (d/m/ft²)	
Mean	93
Range	0 to 780
Samples not included on graph	780
	470
	500
	500

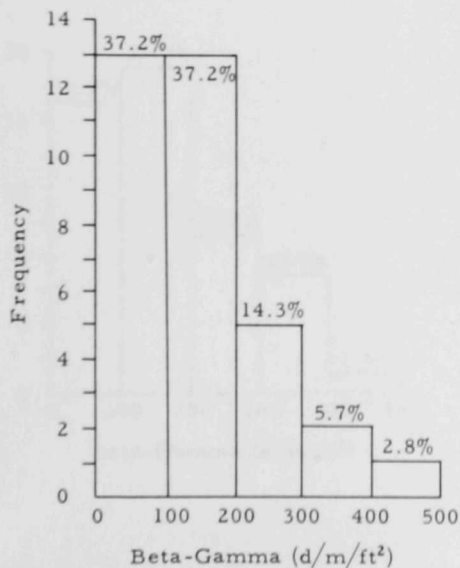
Total number of surveys: 67

HISTOGRAMS OF SMEAR SURVEYS

A-133 (Pu)

Alpha (d/m/ft ²)	
Mean	18.4
Range	0 to 147
Samples not included on graph	147

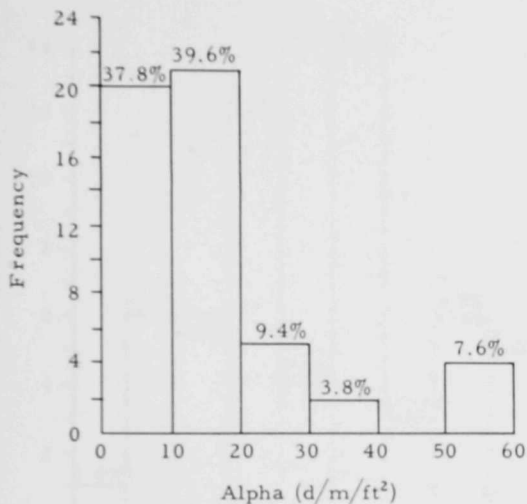
Total number of surveys: 35



Beta-Gamma (d/m/ft ²)	
Mean	166
Range	0 to 870
Samples not included on graph	870

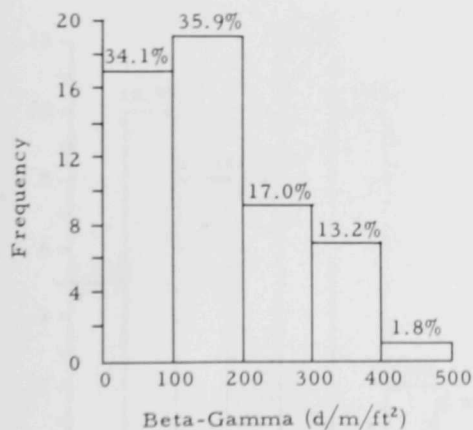
Total number of surveys: 35

HISTOGRAMS OF SMEAR SURVEYS

A-141 (Pu)

Alpha (d/m/ft ²)	
Mean	18.1
Range	0 to 120
Samples not included on graph	120

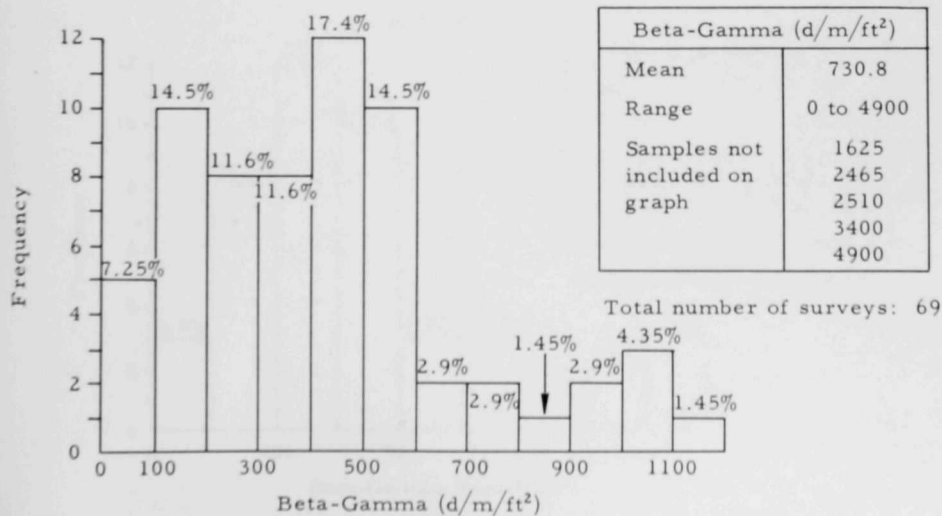
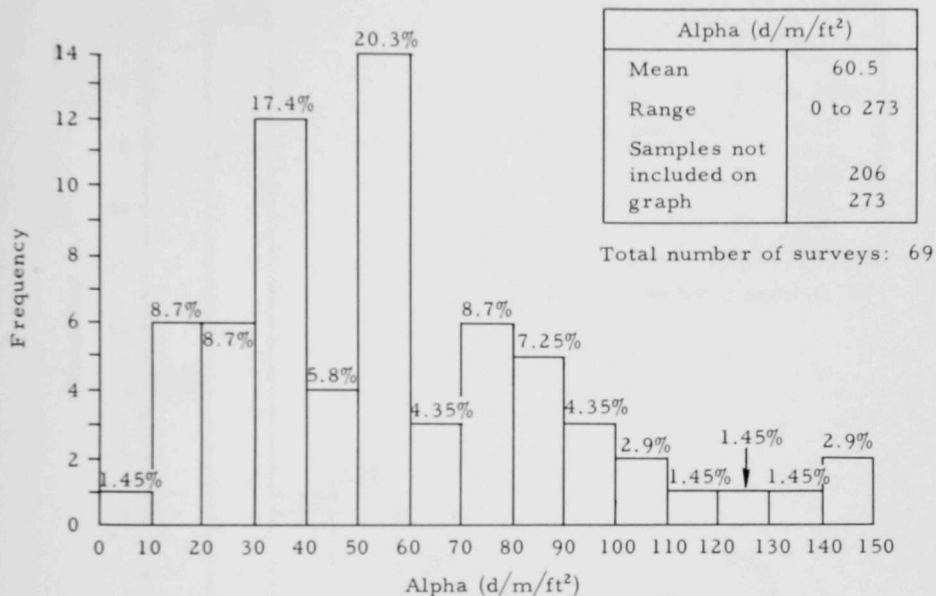
Total number of surveys: 53



Beta-Gamma (d/m/ft ²)	
Mean	147.5
Range	0 to 450
Samples not included on graph	None

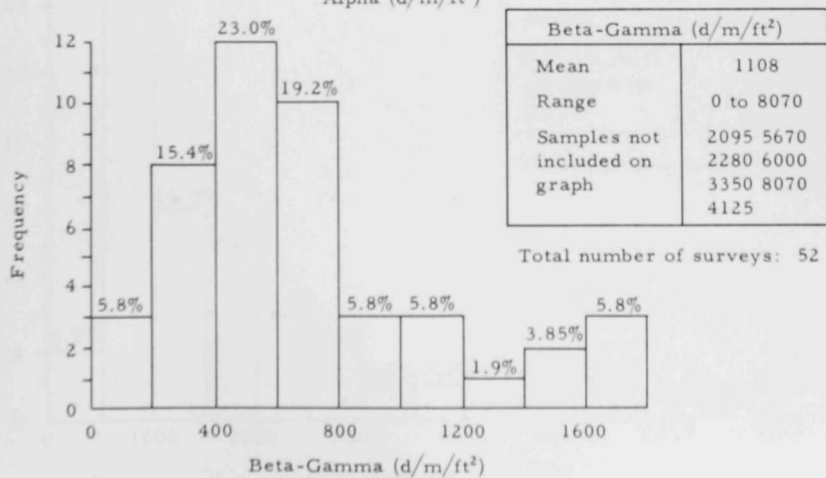
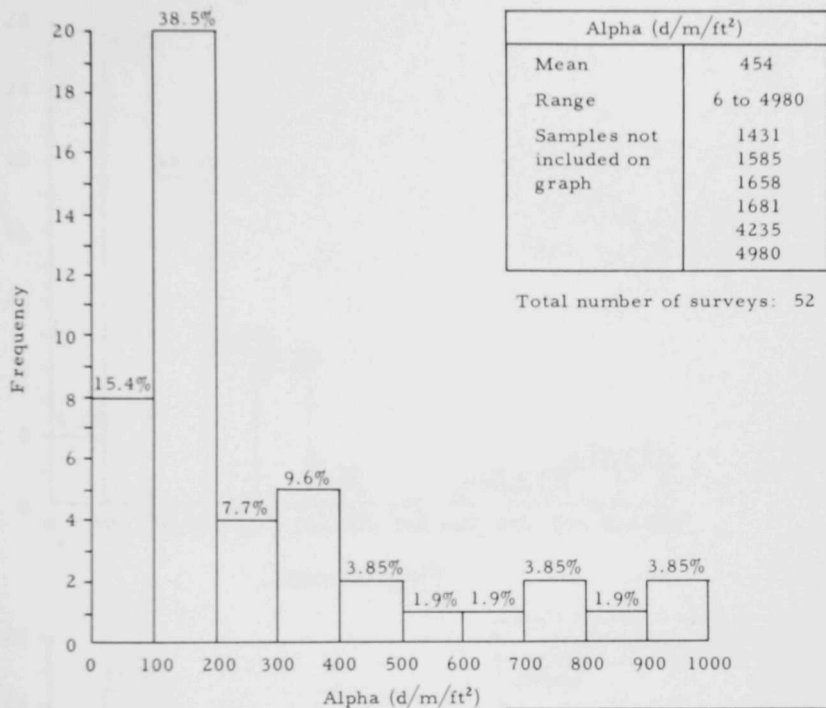
Total number of surveys: 53

HISTOGRAMS OF SMEAR SURVEYS

B-101 (Analytical Laboratory)

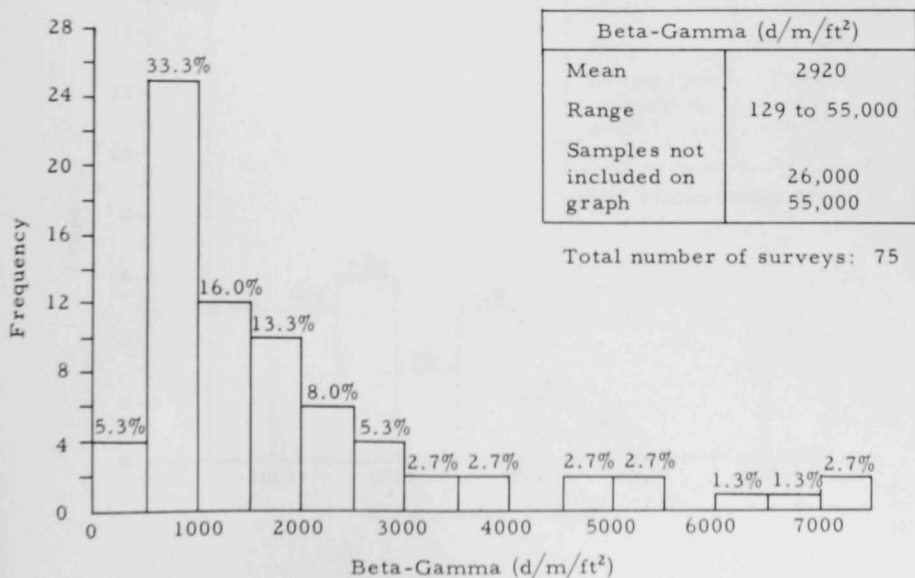
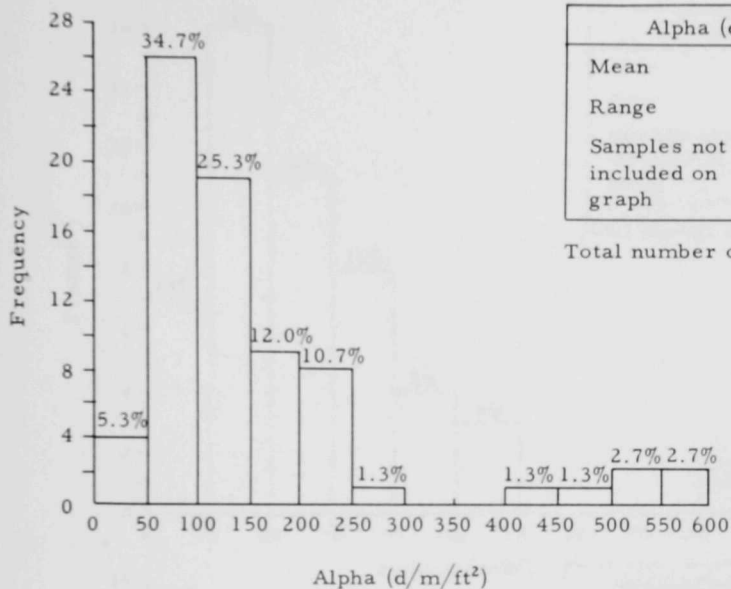
HISTOGRAMS OF SMEAR SURVEYS

B-133 (Th, enriched and normal U)

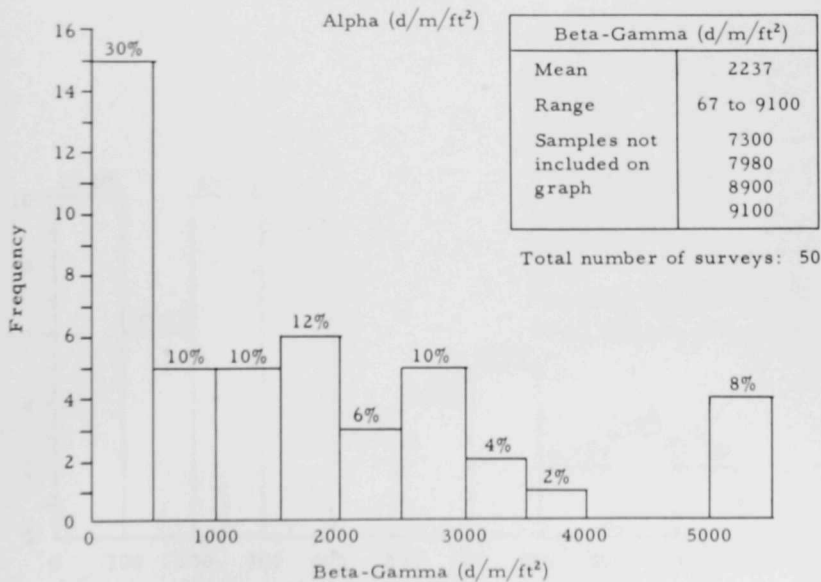
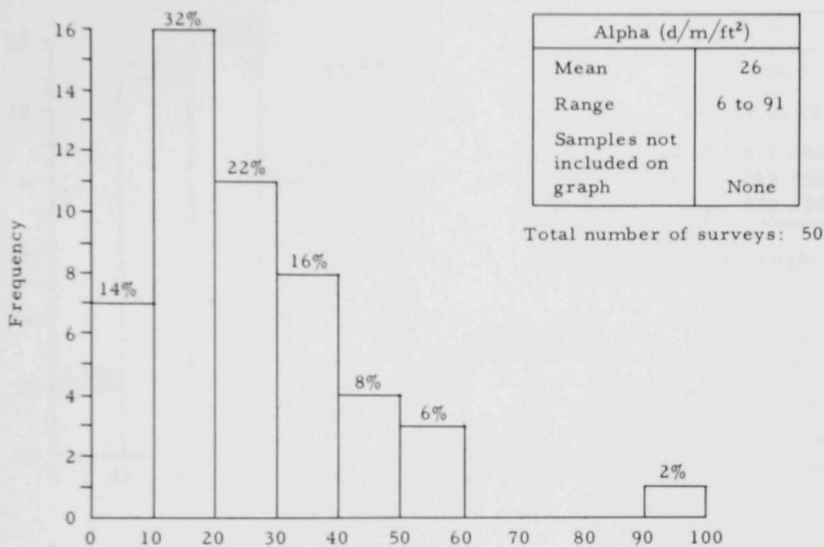


HISTOGRAMS OF SMEAR SURVEYS

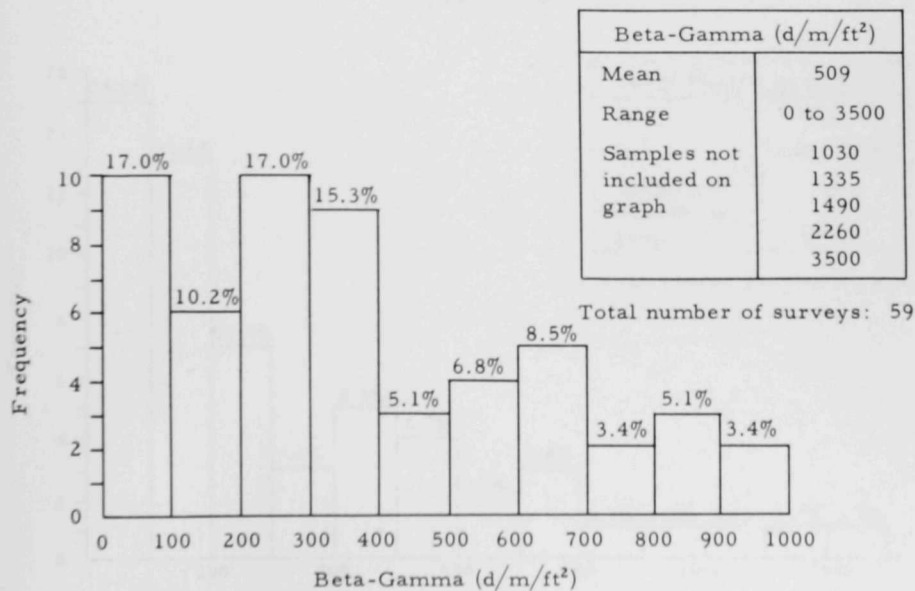
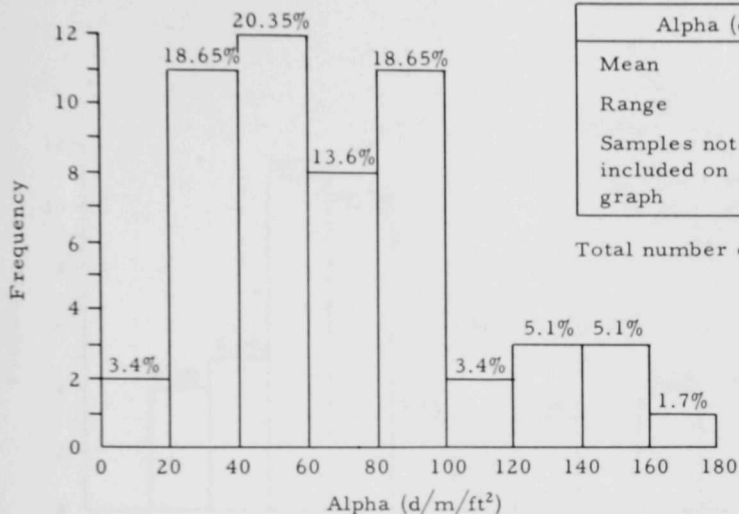
F-111 (Active Storage Area)



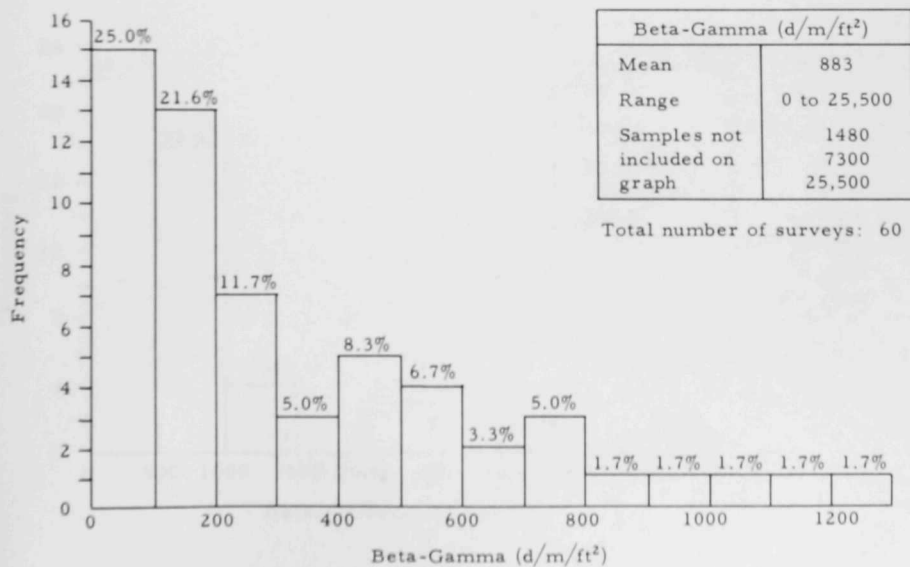
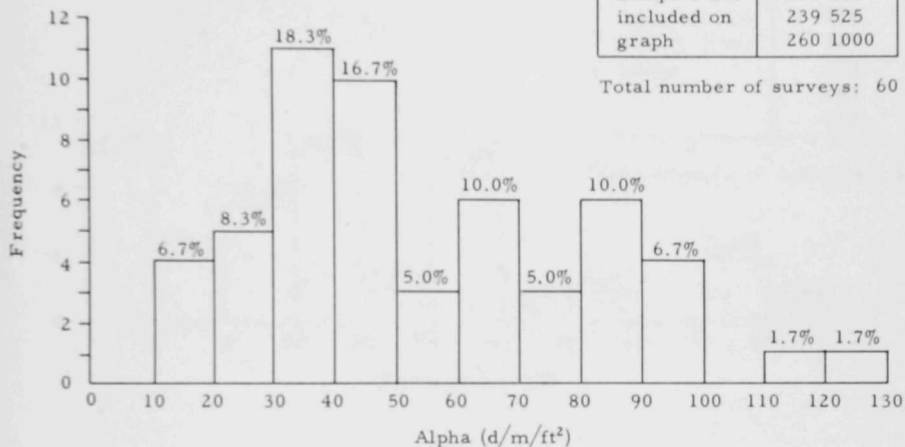
HISTOGRAMS OF SMEAR SURVEYS

G-101 (Jr. Cave Facilities)

HISTOGRAMS OF SMEAR SURVEYS

G-117 (Pu, U)

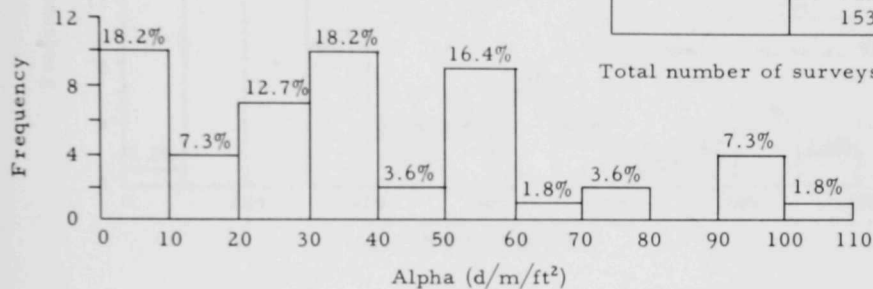
HISTOGRAMS OF SMEAR SURVEYS

H-102 (Pu, U)

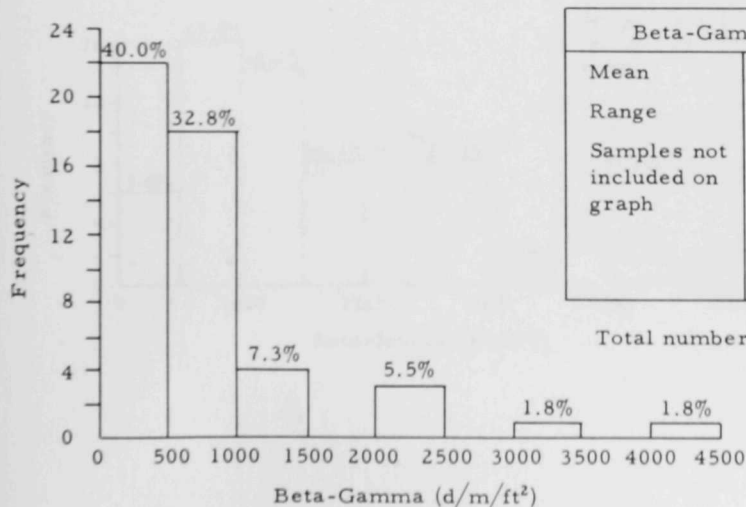
HISTOGRAMS OF SMEAR SURVEYS

H-125 (Irradiated U)

Alpha (d/m/ft ²)	
Mean	47
Range	0 to 153
Samples not included on graph	126
	129
	143
	143
	153



Total number of surveys: 55



Beta-Gamma (d/m/ft ²)	
Mean	9698
Range	120 to 426,000
Samples not included on graph	6870
	7430
	12,000
	26,300
	28,900
	426,000

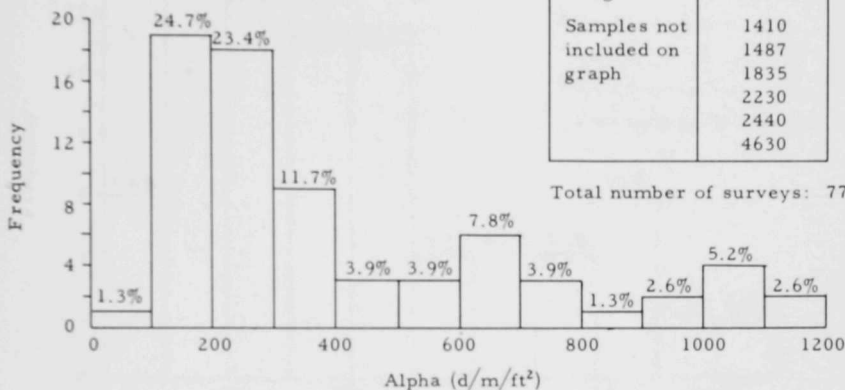
Total number of surveys: 55

HISTOGRAMS OF SMEAR SURVEYS

J-102 (U)

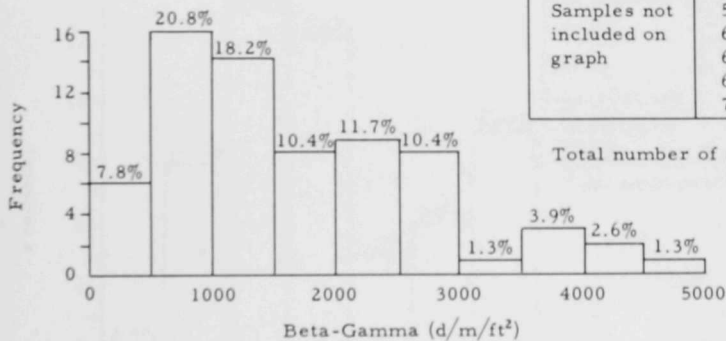
Alpha ($d/m/ft^2$)	
Mean	529
Range	57 to 4630
Samples not included on graph	1410
	1487
	1835
	2230
	2440
	4630

Total number of surveys: 77

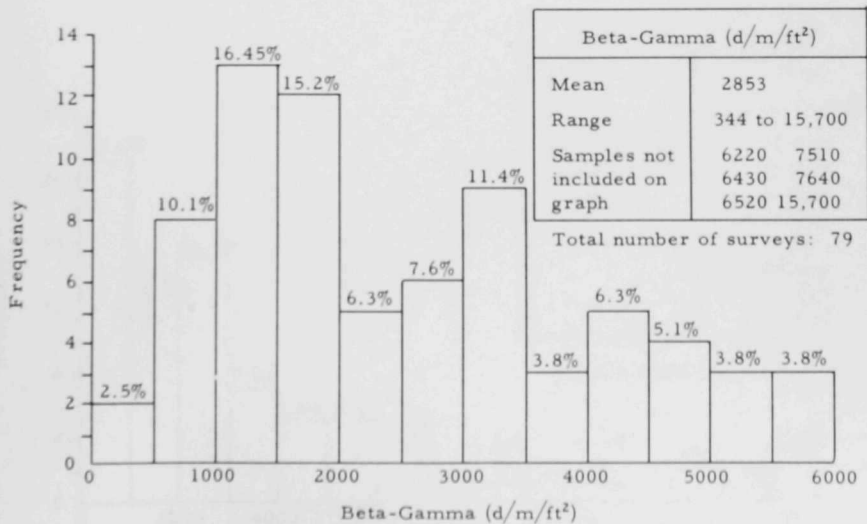
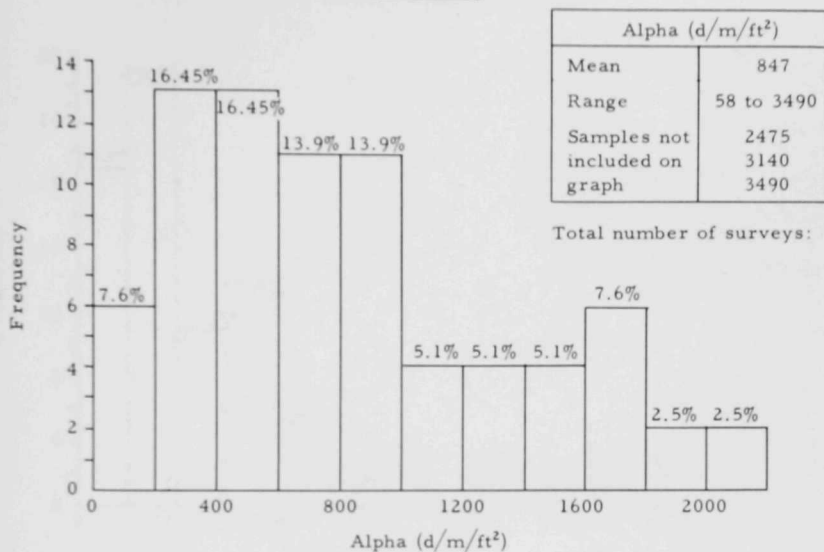


Beta-Gamma ($d/m/ft^2$)	
Mean	2265
Range	292 to 16,750
Samples not included on graph	5660 8000
	6140 8470
	6520 9580
	6743 16,750
	7040

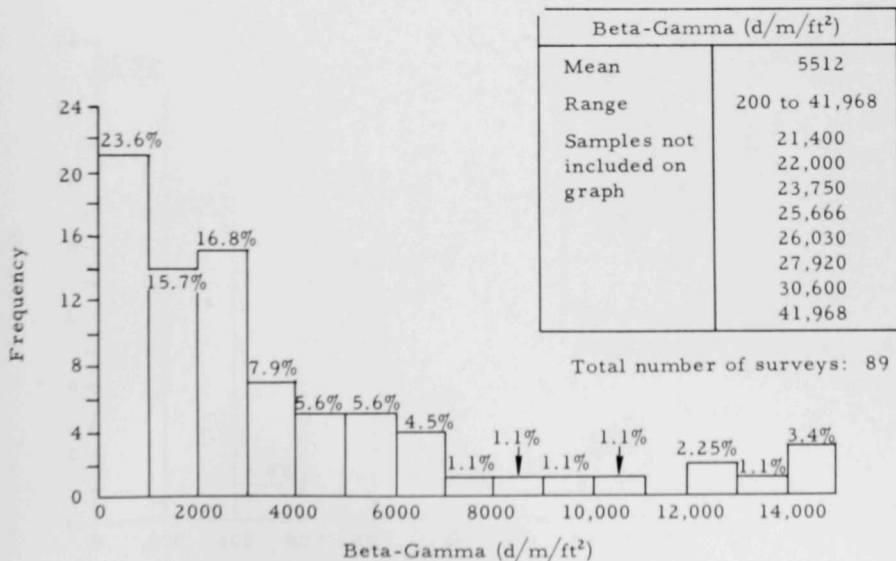
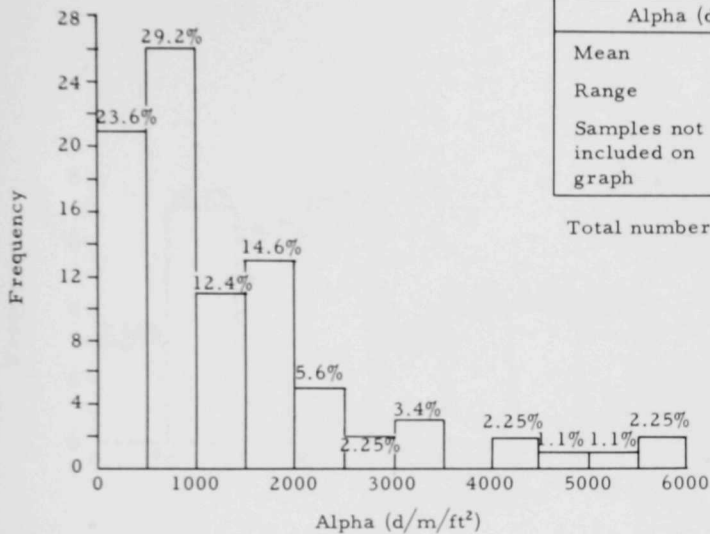
Total number of surveys: 77



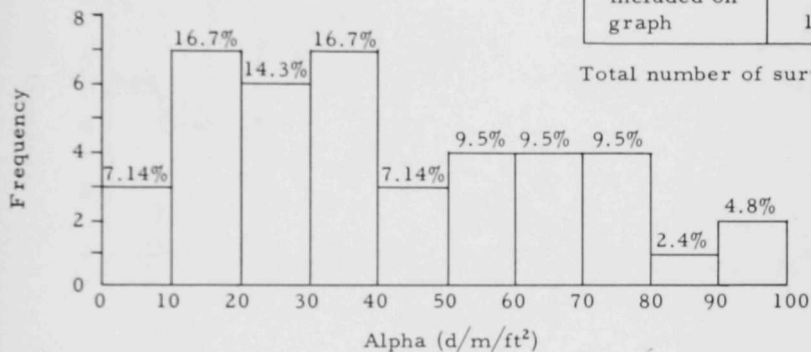
HISTOGRAMS OF SMEAR SURVEYS

J-118 (U)

HISTOGRAMS OF SMEAR SURVEYS

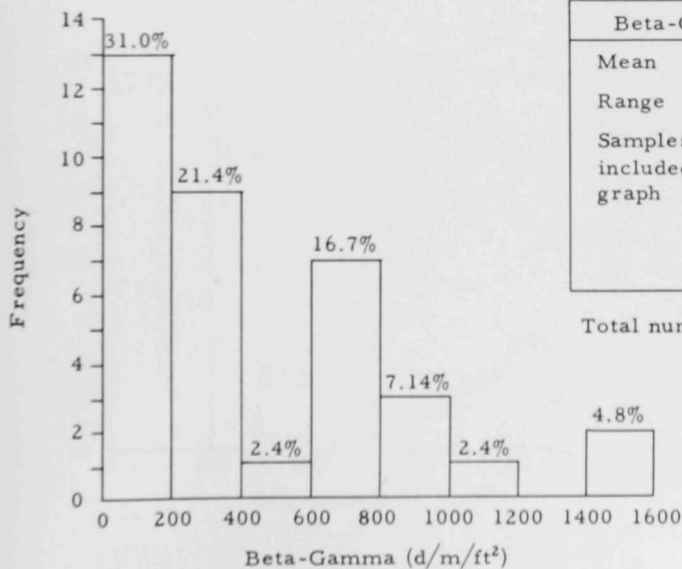
J-134 (Enriched U)

HISTOGRAMS OF SMEAR SURVEYS

K-104 (Cave Operating Area)

Alpha (d/m/ft ²)	
Mean	46
Range	4 to 128
Samples not included on graph	128

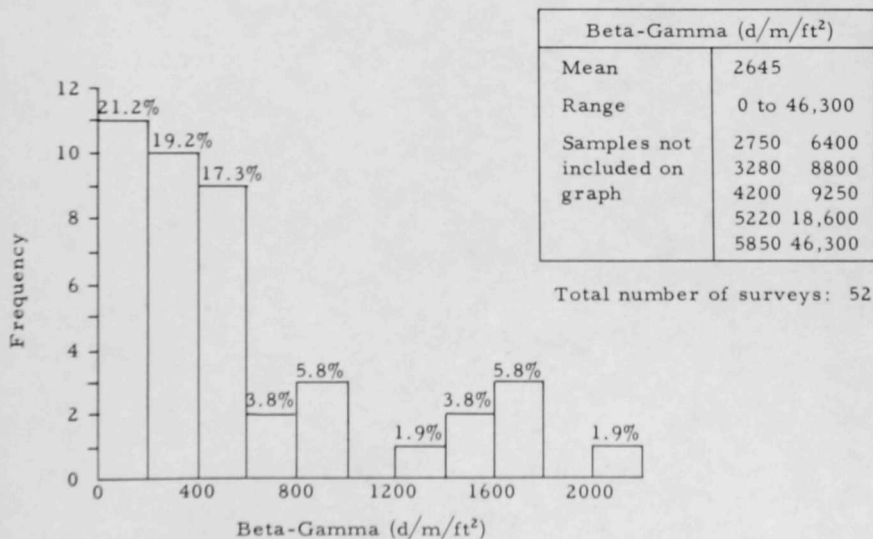
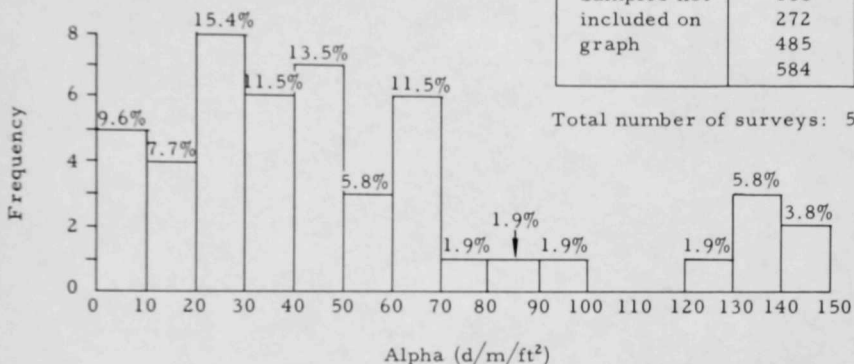
Total number of surveys: 42



Beta-Gamma (d/m/ft ²)	
Mean	2009
Range	0 to 29,450
Samples not included on graph	1905 2580 3470 4450 22,250 29,450

Total number of surveys: 42

HISTOGRAMS OF SMEAR SURVEYS

K-116 (Cave Service Area)

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3 4444 00007737 0

7